Status of the Nearby Supernova Factory Candidate Search

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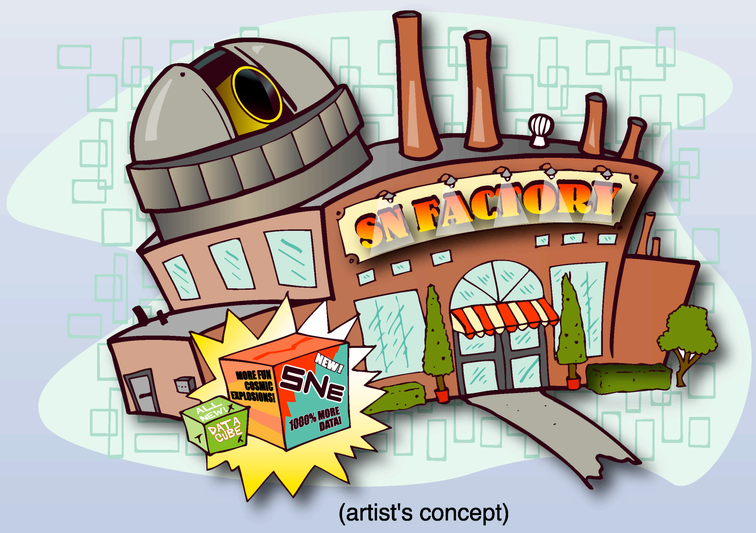
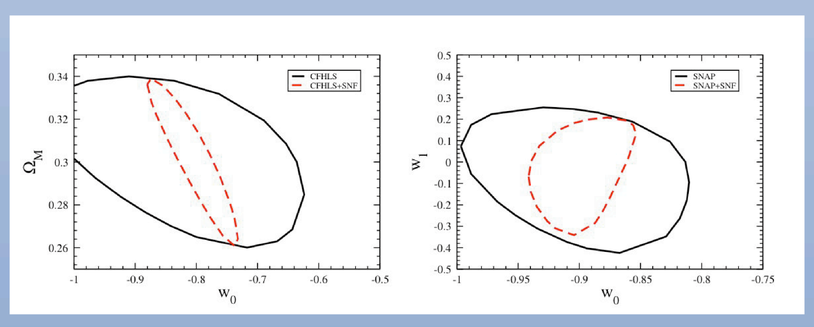


(artist's concept)

The Nearby Supernova Factory (SNfactory) is a project to obtain time series spectrophotometry of a large sample of type Ia supernovae (SNe Ia) in the redshift range 0.03 < z < 0.08. To produce a sample of supernovae unbiased with respect to host galaxy type, SNfactory searches wide-field imaging data taken with the QUEST-II camera on the Samuel Oschin 1.2-m telescope on Mt. Palomar. The camera covers up to 500 square degrees per night to a depth of B = 21, and can be operated either in a point-and-track mode, as by the Near Earth Asteroid Tracking (NEAT) project at JPL, or in a drift-scan mode, as by the Palomar Consortium (Yale/JPL/Caltech). Promising candidates are screened, either photometrically (e.g. with the Nickel 1-m telescope at Lick Observatory or the McDonald Observatory 0.9-m telescope) or spectroscopically with the Supernova Integral Field Spectrograph (SNIFS) on the University of Hawaii 2.2-meter telescope on Mauna Kea (see Lee et al. poster, this session). In its current form, the search discovers some 25 spectroscopically confirmed SNe per month in the NEAT point-and-track data, of which 10-15 are typed as SNe Ia.

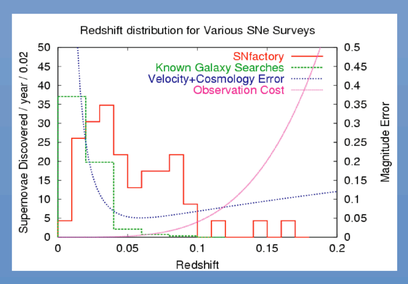
Science:

The large number of SNe Ia produced by the SNfactory will help to anchor the low-redshift end of the Hubble diagram and significantly tighten constraints on cosmological parameters when combined with other data sets at high redshift. Top right: 68% confidence level contours on Ω_M and w_0 from SNLS without (dark solid) and with (red dashed) the SNfactory data set. Bottom right: 68% confidence level contours on w_0 and w_1 from SNAP +/- SNfactory. Both plots assume a flat universe and a prior of $\sigma(\Omega_M) = 0.04$.



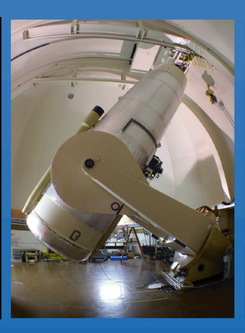
Another of the major SNfactory science goals is to produce a large library of SN Ia optical spectra at all phases, encompassing SNe Ia with a wide range of behaviors and physical properties, and illuminating the underlying relationships between different observational subclasses of SNe Ia which might be used in cosmological fits. The library can be used to improve the accuracy of K-corrections for high-redshift supernovae where detailed spectroscopy at all phases is not feasible. SNfactory will also analyze the data set to look for scaling relations (similar to e.g. the light curve width) which can reduce the dispersion of calibrated SN Ia luminosities in a Hubble diagram.

Search:



The SNfactory searches for SNe Ia with redshift 0.03 < z < 0.08. These SNe are distant enough that cosmic expansion dominates over random peculiar velocities as the main contribution to the redshift, yet close (and thus bright) enough to screen with small (1-m class) telescopes, and to follow up with SNIFS on a 2-m SNIFS on a 2-m class telescope. Typical exposure times for SNIFS are 1000 s or less, allowing spectra of 9 or more SNe in a typical half-night of observing (including calibration).

The search for new type Ia supernovae (SNe Ia) is performed with data from the NEAT (JPL) asteroid search and QUEST (Yale) groups, using the Samuel Oschin 1.2-m telescope at Palomar (bottom left). About 50 GB of image data are produced by the search every night, and transferred from Mt. Palomar using the High Performance Wireless Research and Education Network (HPWREN); one of the HPWREN radio transmitters is shown below (bottom center). The data are archived on the High Performance Storage System (HPSS), a 2-PB tape storage facility at the National Energy Research Scientific Computing Center (NERSC) in Oakland, CA (bottom right). More than 40 TB of images taken with the Oschin telescope are archived there, and remain available for reference images in search operations or for constructing historical light curves of supernovae.

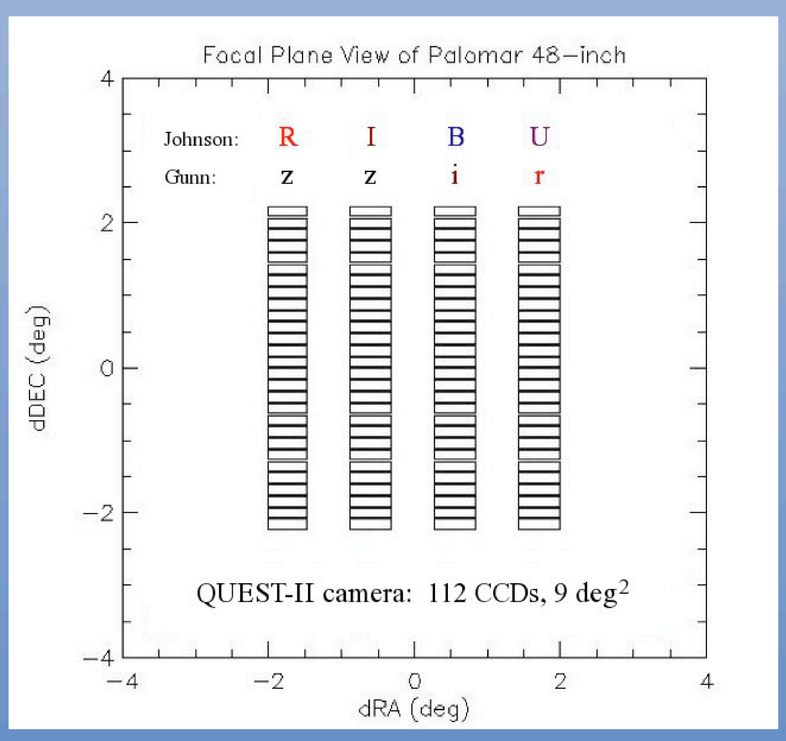




Camera/Screening:

The search telescope is equipped with the QUEST-II camera, covering a total area of 9 square degrees. Its 112 CCDs are arranged in four separate columns, or "fingers", each with 28 CCDs. The camera can be operated in two different readout modes.

The NEAT group runs the camera in point-and-track mode, in which a given sky field is imaged in a single red (RG-610) filter, three times in the span of a half-hour. The multiple images allow the SNfactory search to automatically reject moving objects such as asteroids. About 60% of the telescope's time is spent in point-and-track mode.

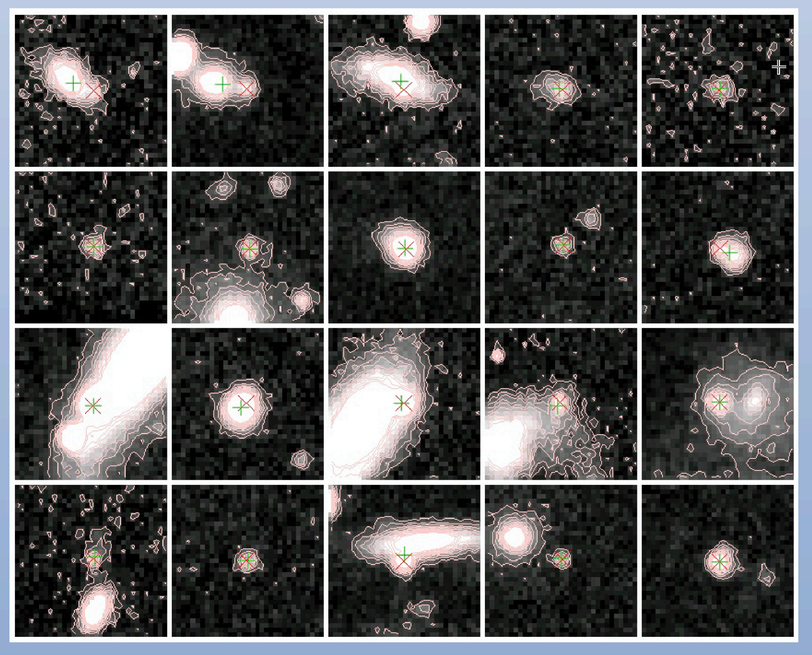
The QUEST group uses the camera in drift-scan mode, in which each finger images in a different filter (Johnson RIBU or Gunn zzir), providing near-simultaneous multicolor imaging of the sky over the course of one drift scan. This allows candidates found in the QUEST data to be photometrically screened by color without the need for additional follow-up operations (the method is under development).



Every morning the SNfactory search pipeline automatically processes the previous night's new images using the NERSC Parallel Distributed Systems Facility 400-node computing cluster. Images are subtracted from previously observed reference images, and routines automatically identify new SN Ia candidates among the background of variable sources. These candidates are confirmed by human inspection and, along with all previous observations, are stored in a database used by automatic scheduling routines to direct SNIFS spectroscopic followup observations (see Lee et al. poster).

While the most promising supernova candidates are sent directly to the SNIFS spectrograph on Mauna Kea (see Lee et al.), for many candidates additional information is desirable before taking a spectrum, especially in cases where the object is faint or has a dim or undetected host galaxy. Photometric screening observations are performed at the Nickel 1-m at Lick Observatory, and at the 0.8-m telescope at the McDonald Observatory of the University of Texas. Each candidate is imaged in the same band as the corresponding discovery image, and candidates are selected for spectroscopic follow-up based on its rate of brightening. (Sources which brighten slowly or are fading are clearly not young SNe Ia.) About 20 candidates per night may be screened in this way. In the future, observations may also include multi-band photometry and light curves for cosmology.

Discovery:

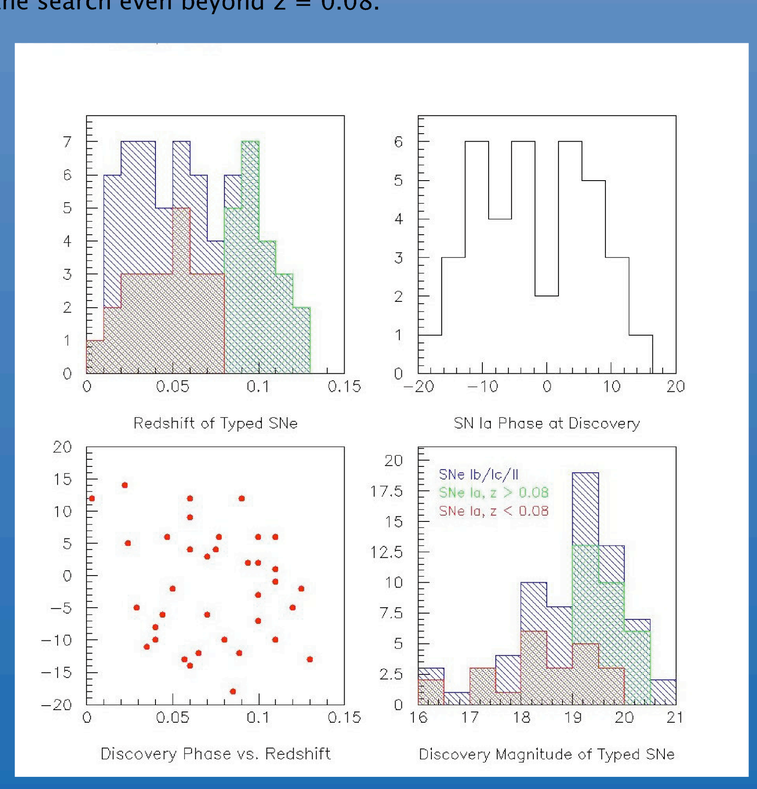


Above: Discovery images from the SNfactory search; the SN is centered in each image. Since June 2005, SNIFS has spectroscopically confirmed 72 supernovae discovered in the search data taken by the Palomar surveys, 46 of which were SNe Ia. During this time period the search found an additional 66 promising supernova candidates, most of which were too faint for SNIFS to provide efficient spectroscopic confirmation.

Nearly all (> 90%) of the supernovae found in the SNfactory search were associated with galaxies not found in any current redshift survey. About a third of the confirmed SNe Ia, and half of the core-collapse supernovae, were associated with anonymous host galaxies not listed in NED, or had very faint or invisible hosts. These supernovae would not have been found in any search which targeted only galaxies with known redshifts and morphologies.

SNIFS has also typed 26 supernovae discovered by other observers, including those reported in the IAU Circulars, since the start of regular SNIFS observing in June 2004.

Below: Some aggregate properties of SNe found by the SNfactory search and typed by SNIFS since June 2005. The search can find supernovae throughout, and beyond, the SNfactory's target redshift range. Pre-max (phase of -7 days or younger) SNe Ia are found by the search even beyond z = 0.08.



For more information on the SNfactory, contact Richard Scalzo (RAScalzo@lbl.gov) or Greg Aldering (GAldering@LBL.gov) or visit our webpage at http://snfactory.lbl.gov/